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(54) Paper spinning

(57) In the production of a paper yarn a strip 3 of paper is drawn from a reel 2 and is dampened by passing under a roller 14 dipping into a trough 10. After passing through a squeezing device 7, it is led to a V-pulley 11 which produces a slight longitudinal fold in the strip. The strip 3 together with an optional reinforcing strand 5 drawn from a package 13 then passes downwardly through a rotary spindle 20 fitted at its lower end with a false twist device 21 and carrying a package 28 of binder material. The false twist applied by the device 21 passes upwardly through the spindle 20 and compacts the folded strip 3 which is caused to envelope the strengthening strand 5. The compacted and reinforced paper strip is encircled by yarn from the package 28 as it enters the spindle 20 and the wrapped yarn leaving the false twist device 21 is fed forwardly by rollers 30 and 31 and is wound into a package 32 by a winding head 34.

Fig. 3.

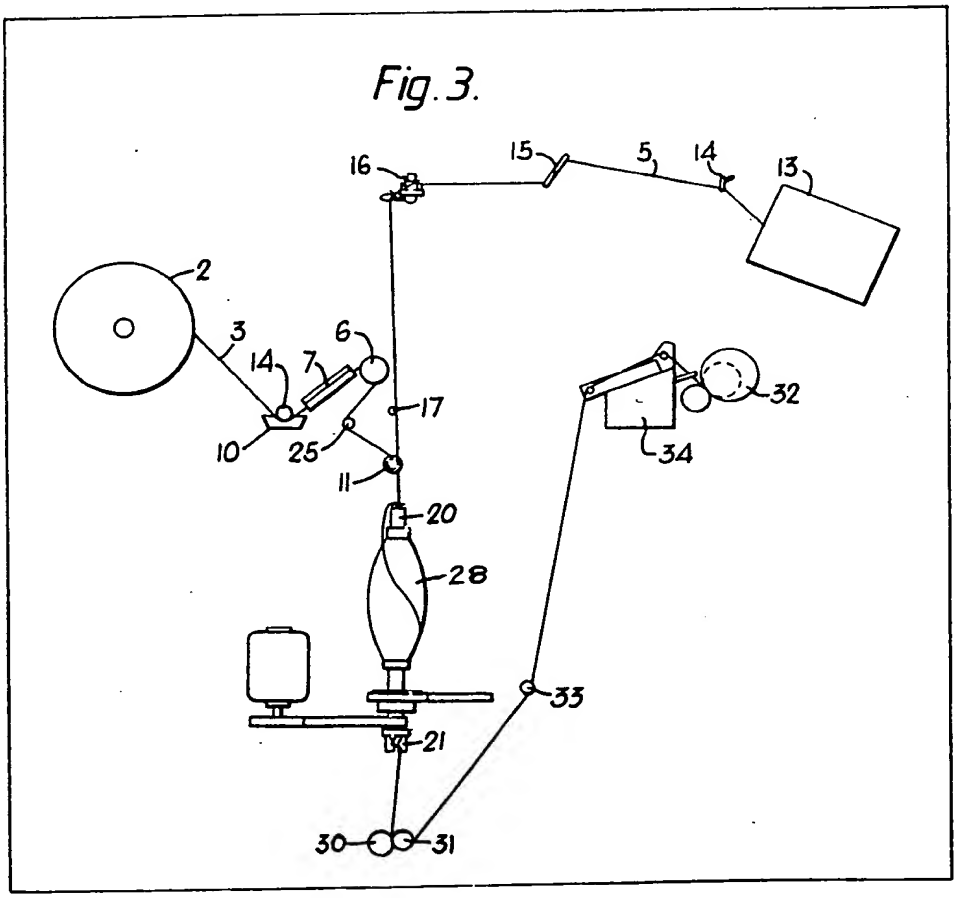


Fig. 1.

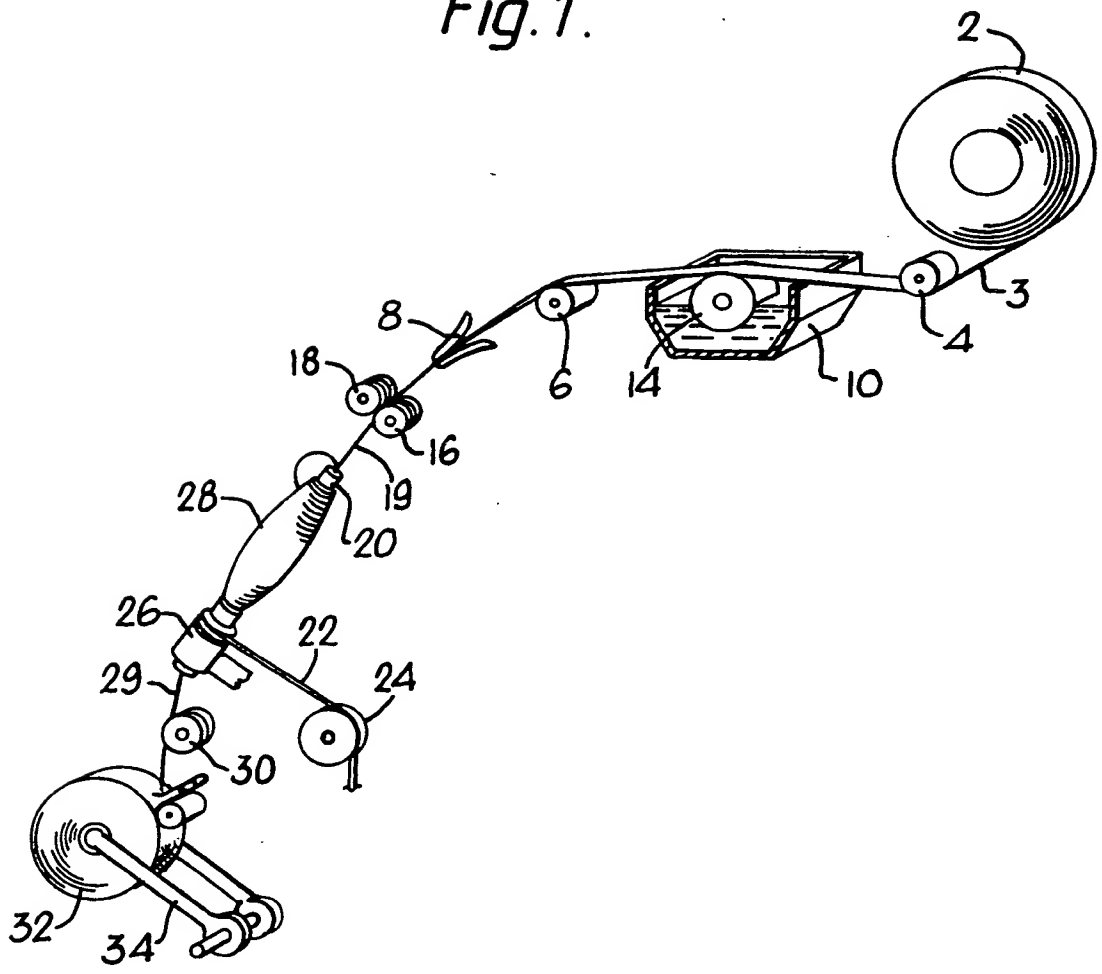


Fig. 2.

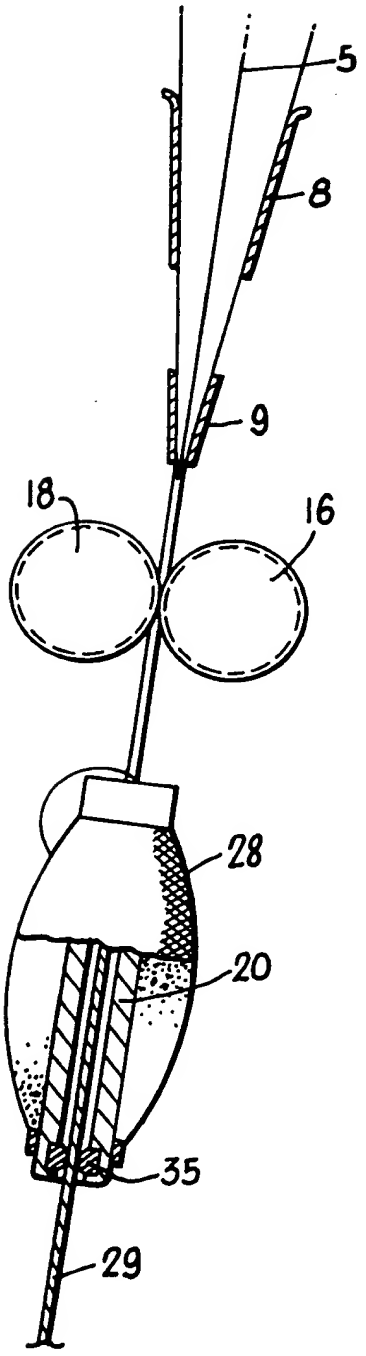


Fig. 4.

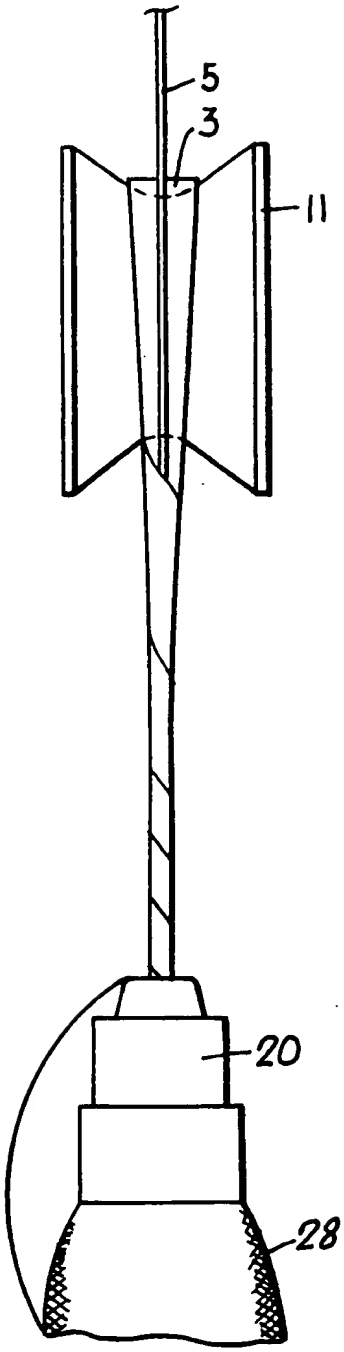
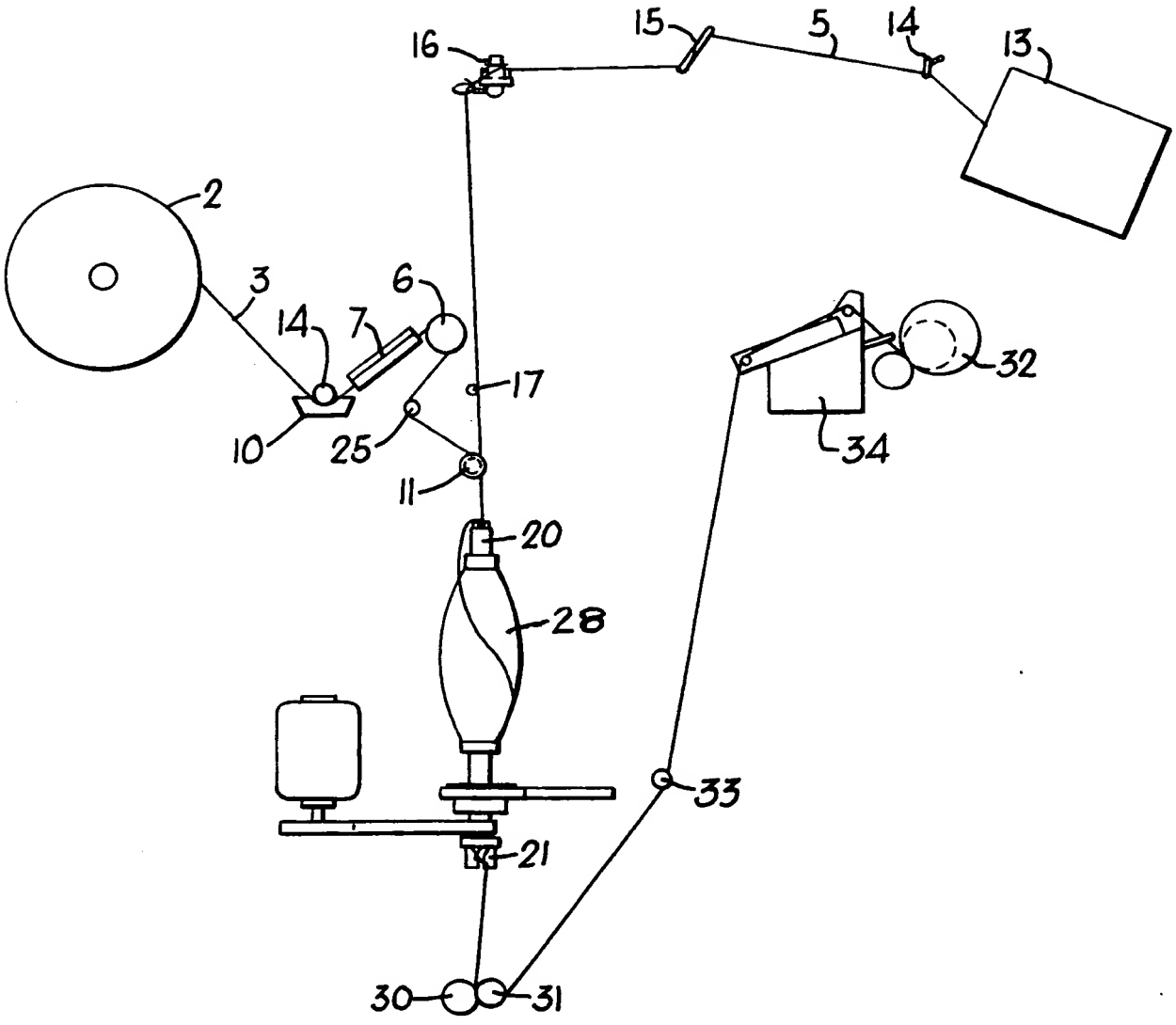


Fig. 3.



SPECIFICATION

Paper spinning

The production of yarn from paper strip by folding the strip and then twisting it by means of a conventional spinning process has been known for many years. The yarn, however, can suffer from a lack of tenacity, particularly during formation if damp, a tendency to kink and a lack of smoothness which can present problems in weaving.

According to the present invention, a paper yarn is produced by compacting a strip of paper and then binding the compacted strip by means of a wrap spinning process. Not only does this make it possible very significantly to increase the throughput and wind-up speeds of the process, but it has also been found that the binding of the yarn increases its tenacity and the absence of true twist gives a smoother yarn and reduces its tendency to kink.

The wrap spinning process involves the use of a hollow spindle which supports a package of wrapper yarn and through which the paper strip is passed. The wrapper yarn passes through the spindle with the paper strip, being withdrawn over end from the package, and rotation of at least part of the spindle causes the wrapper yarn to spiral around the compacted paper strip in a helical path so as to carry out the binding action referred to above. The resultant yarn is then wound onto a package.

The necessary compaction may be produced by passing the strip through a restricted passage way in order to condense the strip. The wrapping action may occur either at the entry end or the exit end of the hollow spindle and if the former, the paper strip is best compacted in advance of the spindle. If the wrapping is carried out at the exit end of the hollow spindle, compaction may occur either before reaching the hollow spindle or while the strip is passing through the spindle.

When a wrap spinning process is applied to a fibrous core it is common practice to apply false twist to the core so as to assist cohesion of the fibres during the wrapping step. Such false twist may be applied, for example, either by a separate false twist device or by engagement of the core material or the wrapped yarn with a rotary part of the hollow spindle. In a method according to the invention, when compaction of the paper strip is produced by condensation as just described, false twisting of the compacted strip may assist the cohesion of the compacted paper. The need for such false twisting depends largely on the operating conditions since under some conditions it may have an adverse effect on the smoothness and regularity of the resultant yarn in a similar manner to the conventional twisting process referred to originally. In other words, the application of false twist may be regarded as optional and depending largely on the nature of the paper being used, the presence or absence of a wetting agent such as water and also the type of final product required.

If false twisting is to be applied by way of a part rotating with the hollow spindle carrying the wrapper yarn, the part in question may be combined with the condenser, so that false twist may be applied simultaneously with the condensation of the strip.

Under some circumstances, particularly when working with a relatively narrow paper strip, false twist can be used instead of rather than in conjunction with condensation to produce the necessary compaction. When this is done, compaction is assisted if the strip is at least slightly folded in a longitudinal direction prior to twisting. Whatever method is used in order to obtain compaction, the obtaining of a regular yarn is assisted if a liquid is applied to the strip prior to compaction. Generally speaking this needs to be a wetting agent such as water, as referred to above. This increases the pliability of the paper and assists in the even compaction of the strip. If desired heating apparatus may be positioned along the path of the compacted paper so as to dry it or partially dry it prior to the finished yarn being wound into a package.

Although compaction is preferably carried out in such a way as to give the compacted strip a generally circular configuration, additional smoothness may be obtained by an additional rounding or smoothing action applied to the yarn either before or after the wrapping step. In addition to the smoothing effect of the wrapping material, this also enhances the tensile strength of the resultant yarn by its compressive and binding effect on the compacted paper strip.

Should it be necessary to obtain greater tensile strength, a strengthening strand may be advanced with the paper strip so as to become encased by the strip after compaction and thus to be invisible in the final product. The strengthening strand may be of thermoplastic material and if in the form of a yarn it may be either a mono- or multi-filament yarn or a thermoplastic tape which may be fibrillated either prior to use or which becomes fibrillated during compaction of the tape. Similar material may also be used for the so-called "wrapper yarn". In particular this yarn may be a mono- or multi-filament fine denier yarn.

Apparatus for carrying out a process in accordance with the invention consists basically of a wrap spinner fitted with additional components for supplying the additional requirements of the method. Thus in addition to the normal driven hollow spindle for carrying a binding or wrapper yarn together with a draw-off roller or rollers for pulling the resultant yarn through and away from the spindle and winding mechanism for winding the yarn into a package, the apparatus needs to include a support for a reel of paper, a wetting device positioned upstream of the spindle and guides for directing a paper strip from a reel on the support to the wetting device and for positioning the damp strip relative to the entrance of the spindle. If compaction of the paper strip is to be produced by false twist alone, the hollow spindle needs to include either a falst twist device or to be

so adjusted as itself to apply the necessary false twist. On the other hand, if the yarn is to be compacted by condensation, the apparatus needs to include a device defining a restricted passage way for condensing the paper strip prior to wrapping. Generally speaking this device needs to be located upstream of the spindle, but as an alternative it may be mounted along the length of the spindle, preferably at the entry end, e.g. in the form of a stationary tube which supports bearings on which the spindle turns. The presence of the condensing device at the entry or along the length of the spindle means that the wrapping must occur at the exit of the spindle. Instead of being stationary, the condensing device may rotate with the spindle, the entrance to the spindle being modified for this purpose. The fact that the condensing device rotates with the spindle means that false twist may be applied to the paper strip as part of the condensing process and the device thus serves as a combined condenser and false twist device. Again, wrapping needs to occur at the exit end of the spindle.

If a rotary condenser is used, it need not form part of the spindle entry, but may be mounted slightly upstream of the entry so that wrapping can be carried out at the entry to the spindle. Such a rotary condenser may be used either on its own or in conjunction with a stationary condenser. For example, a stationary condenser may be followed by a pair of feed rollers which pull the paper strip through the condenser and which are followed by a rotary condenser which may be either combined with the entry to the spindle or may be independent of it, being separately driven. A further alternative is for a rotary condenser to be mounted at the entry to the spindle, but nevertheless to be independent of it. In other words, the condenser constitutes an inner spindle formed with a tapered bore so as to produce the necessary condensing action and driven independently of the main spindle. This inner spindle may terminate in a guide eye which acts to round the condensed paper strip and which may be either rough or smooth depending on whether or not it is desired to apply false twist. With this construction also the binding or wrapping action must occur at the exit end of the main spindle. The condenser may also be provided with heating elements to assist in the drying of the paper.

Examples of process and apparatus in accordance with the invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic perspective view of one form of process and apparatus;

Figure 2 is a partly sectional view to an enlarged scale of a modified form of some of the components of the apparatus shown in Figure 1;

Figure 3 is a diagrammatic view of an alternative form of process and apparatus; and

Figure 4 is a detailed view to an enlarged scale of part of Figure 3 seen from the right hand side.

Figure 1 shows the basic arrangement of components necessary for the operation of one form of process in accordance with the invention. The Figure illustrates a single wrapping head drawing paper strip from a reel shown as 2, but it will be understood that this may form a single unit in a multiple machine and that individual reels 2 may be mounted on a common support or alternatively paper may be withdrawn in the form of a web from a roll which is the equivalent of a number of individual reels 2, the paper web being slit into individual strips before passing to the separate wrapping heads. In the arrangement illustrated in Figure 1, the paper strip shown as 3 passes under a guide roller 4 and then over a further guide roller 6 before passing to a condenser 8. A damping trough 10 is situated between the rollers 4 and 6 and holds a quantity of wetting agent 12 which may be water either with or without various additives such as a fungicide. The paper strip 3 bears against the surface of a roller 14 which is partly immersed in the wetting agent 12 and which is thereby caused to rotate and to dampen the paper strip. If required, a positive drive may be provided for the roller 14 so as to drive it either in the same or the opposite direction of travel of the strip 3.

The strip 3 is pulled from the reel 2 along the path just described and through the condenser 8 by means of a pair of grooved rollers 16 and 18, from where it is passed to a rotary spindle 20. The condenser 8 is of the tapered funnel type and the paper is thereby folded longitudinally and compacted, the dampening of the paper assisting in the compacting procedure. If the wetting agent 12 is sized, this may also help to bind the folds of paper together.

The rotary spindle 20 carries a package 28 of binder material such as nylon filament. This is withdrawn over-end and wraps the condensed paper shown as 19 at the entrance to the spindle. The spindle 20 is driven by a belt 22 passing around a pulley 24 and is supported by a mounting 26. As explained above, the application of false twist is optional, depending on the precise conditions and if no false twist is to be applied, the condensed paper core 19 passes through the hollow interior of the spindle 20 without making contact or with only a minimum contact with it. On the other hand, if false twist is required, the spindle 20 may be adjusted so that the condensed paper core 19 engages the wall of the spindle at the exit end and this may be serrated or otherwise treated to cause it to grip the paper and drive a false twist back along the paper core as far as the nip of the forwarding rollers 16 and 18 so that false twist is present at the wrapping point. The pitch of the wrapping applied by the binding material depends on the speed at which the paper 19 is drawn through the spindle and the speed of revolution of the spindle 20.

The wrapped yarn is withdrawn from the spindle 20 by a grooved haul pulley 30 and then wound into a package 32 on a winding head indicated generally as 34. The grooves both in the rollers 16 and 18 and in the haul pulley 30 are preferably shaped so as to provide a smoothing

and rounding action both to the paper core prior to wrapping or binding and to the resultant product after binding, thus further augmenting the beneficial effect resulting from the production of a wrapped rather than a continuously twisted yarn.

Figure 2 shows to an enlarged scale a modification of certain of the parts of Figure 1, those parts which are unmodified being identified by the same reference numerals. Thus, in the construction of Figure 2, the funnel shaped condenser 8 seen in Figure 1 is followed by a second condenser 9 which further compacts the paper strip 3. In addition, a reinforcing or strengthening filament 5 is fed through the centre of the condensers 8 and 9 so as to become enclosed within the folded paper. Thus the first condenser 8 may be shaped to fold the paper into a U-shape with the filament 5 along the bottom of the U, and the second condenser may completely close the paper around the filament 5 and compact it into a rounded, circular shape. One of the modifications illustrated in Figure 2 is the provision of an eye 35 at the exit end of the spindle 20. If false twist is required in addition to the compaction produced by the two condensers, this eye may have a roughened surface so as to grip the yarn and apply false twist. Alternatively the eye may have a smooth, polished surface to as to have a smoothing and rounding action on the yarn 29.

In the process and apparatus illustrated in Figures 3 and 4, the compaction of the paper strip is produced solely by false twisting. Many of the components are the same as in Figure 1 and are therefore identified by the same reference numerals. Thus a paper strip 3 is drawn from a roll 2 and passes beneath a roller 14 which is free to rotate in a water damping trough 10. In this arrangement, no feed rollers are provided in advance of the spindle 20 and the paper is drawn forwardly through the successive components solely by the action of the rollers 30 and 31, the roller 31 being positively driven and the roller 30 being resiliently loaded against the roller 31. After leaving the damping trough 10, the paper strip 3 passes through a squeezing device 7 which may, for example, comprise a pair of rubber aprons lightly loaded against one another and which controls the residual moisture in the paper. As an alternative, the device may comprise two or three staggered edges which cause the paper to follow a zig-zag path and hence remove any surplus moisture.

The strip 3 next passes around a freely rotatable flanged guide roller 6 which controls lateral movement of the strip. After leaving the guide roller 6, the strip passes around a further guide member 25 and then to a V-pulley 11 which produces a slight longitudinal fold in the paper strip, as best seen in Figure 4. The strip 3 together with a reinforcing strand 5 then passes downwardly through a rotary spindle 20 fitted at its lower end with a false twist device 21 which rotates with the spindle. The slight folding action produced by the roller 11 assists the paper strip 3 in encasing the reinforcing strand 5 and, in conjunction with the falst twisting action leads to a neatly rounded yarn which is then wrapped. The reinforcing strand 5 is drawn from a package 13 by way of guides 14 and 15, tensioning device 16 and guide rod 17 before joining the paper strip 3 at the surface of the pulley 11. The yarn components are drawn through the spindle 20 by the rollers 30 and 31 as previously described and then pass around a guide 33 to a winding head 34.

The presence of the squeezing device 7 exerts close control over the quantity of moisture remaining in the paper strip. This is desirable in order to obtain neat compaction of the strip to form the yarn, but may cause problems, particularly due to the additional weight, in the final package. Accordingly, a heater may be included at a point after the exit end of the spindle in order at least partially to dry the completed yarn prior to winding.

When the overall strength of the yarn is a primary consideration, it may be necessary to apply more than one wrapper yarn by passing the compacted paper strip in succession through two or more hollow spindles. If just two wrapper yarns are used, they may be wound with the same or opposite hands, the latter generally providing a somewhat greater strengthening effect.

CLAIMS

1. A method of forming a paper yarn in which a strip of paper is compacted and the compacted strip is bound by means of a wrap spinning process.

2. A method according to claim 1 in which the compaction is produced by passing the strip through a restricted passage way in order to condense the strip.

3. A method according to claim 2 in which the strip is condensed before passing to a rotating hollow spindle carrying the wrapper yarn.

4. A method according to claim 2 in which the strip is condensed while passing through a rotating hollow spindle carrying the wrapper yarn.

5. A method according to any one of claims 2 to 4 in which the condensed strip is subjected to a rounding action.

6. A method according to claim 5 in which the rounding action is applied to the bound strip.

7. A method according to any one of claims 2 to 6 in which the condensed strip is false twisted.

8. A method according to claim 7 in which the false twist is applied by a part rotating with a hollow spindle carrying the wrapper yarn.

9. A method according to claim 8 in which the falst twist is applied simultaneously with the condensation of the strip.

10. A method according to claim 1 in which the compaction is produced by false twisting the strip.

11. A method according to claim 10 in which the falst twist is applied by a part rotating with a hollow spindle carrying the wrapper yarn.

12. A method according to claim 10 or claim 11 in which the strip is at least slightly folded in a

longitudinal direction prior to twisting.

13. A method according to any one of the previous claims in which a liquid is applied to the strip prior to compaction.

14. A method according to any one of the preceding claims in which a strengthening strand is advanced with the paper strip so as to become encased by the strip after compaction.

15. A method according to claim 14 in which the strengthening strand is thermoplastic.

16. A method according to claim 15 in which the strengthening strand is a mono- or multi-filament fine denier yarn.

17. A method according to claim 15 in which the strengthening strand is a thermoplastic tape.

18. A method according to claim 17 in which the tape is fibrillated.

19. A method according to claim 18 in which the tape is fibrillated during compaction.

20. A method according to any one of the preceding claims in which the wrapper yarn is a mono- or multi-filament yarn.

21. Apparatus for producing a paper yarn by means of a method according to claim 1 comprising a support for a reel of paper, a driven hollow spindle for carrying a binding yarn, a wetting device positioned upstream of the spindle, guides for directing a paper strip from a reel to the wetting device and for positioning the dampened strip relative to the entrance of the spindle, a draw-off roller or rollers for pulling the resultant yarn through and away from the spindle and winding mechanism for winding the yarn into a package.

22. Apparatus according to claim 1 including a device defining a restricted passage way for condensing the paper strip prior to wrapping.

23. Apparatus according to claim 22 in which the device is located upstream of the spindle.

24. Apparatus according to any one of claims 21 to 23 including a false twist device.

25. Apparatus according to claims 22 and 24 in which the condensing device forms at least part of the false twist device.

26. Apparatus according to claim 21 and claim 24 in which the falst twist device constitutes the sole means for compacting the strip.

27. Apparatus according to claim 26 in which the false twist device is mounted at the exit end of the rotary spindle.

28. Apparatus according to claim 26 or 27 and including a grooved runner upstream of the spindle for at least slightly folding the strip.

29. Apparatus according to any one of claims 21 to 28 and including means for supplying and guiding a strengthening strand to pass through the spindle with the paper strip.

30. Apparatus according to claims 28 and 29 in which the strengthening strand also passes around the grooved runner.

31. Apparatus according to any one of claims 21 to 30 and including mechanism for reducing the level of moisture in the paper strip in advance of the spindle.

32. Apparatus according to any one of claims 21 to 31 and including a heater for drying the compacted paper strip.

33. Apparatus according to any one of claims 21 to 32 and including a member for rounding the compacted strip.

34. Apparatus according to claim 33 in which the rounding member is situated upstream of the spindle.

35. A yarn comprising a compacted paper core bound with a wrapper yarn.

36. A yarn according to claim 35 and including an internal strengthening strand.

37. A yarn when made by a method according to any one of claims 1 to 20.

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